Scientific Cooperation in the Field of Economics in Selected European Countries

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Abstract. The paper presents the results describing the research productivity in the area of economics in 36 European countries in the period 2011–2020. During the first stage of the research, the publications' distributions over the structure of authors' teams, over the contribution of foreign co-authors and over main research topics mentioned in papers were analyzed. Also the impact of mentioned above features on the number of citations was studied. The authors tested the possibility of building a recommendation system indicating the best way of preparing scientific publications with respect to the number of citations. The results show that the prediction of the exact number of citation is rather impossible, but the main determinants may be identified. The set of the most important factors having a huge impact on the citation measures involves the research experience of authors confirmed by previous publications, the structure of authors' teams, the degree of their internationalization and proper selection of research topics belong to the group of main success factors in publication activity.

Keywords: Research productivity in economics · Analysis of research publications · Success factors in publication activity

1 Introduction

1.1 Scientific Cooperation

From the beginning of the twentieth century, one can observe a phenomenon affecting the life of the academic community, in line with the philosophy of "publish or perish" [1]. Research shows that one of the determinants affecting the level of scientific productivity expressed by the number of publications is scientific cooperation and the intensity of cooperation increases with increasing productivity [2]. Sonnenwald defined scientific collaboration as interaction taking place within a social context among two or more scientists that facilitates the sharing of meaning and completion of tasks with respect to a mutually shared, superordinate goal [3]. During the last few decades the scientific collaboration, both at intra-country and international levels, has increased rapidly in diverse research areas [4]. Literature of the subject point to some features characteristic for the development of scientific cooperation:

- Factors based on cultural, linguistic and institutional differences cause additional obstacles to long-distance cooperation [5];

- There is a greater tendency to cooperate with scientists with a higher level of scientific productivity [2];
- International cooperation is lower in countries with a lower level of science and technology [6];
- Co-authored works have a better chance of being accepted for publication than works by a single author [7];

The network of international co-authorship relations has been dominated by certain European nations and the USA, but this network is rapidly expanding at the global level [8]. Scientific collaboration is an important mechanism that enables the integration of the least developed countries into research activities [9].

The authors of the paper established the following list of research goals:

- analysis the distribution of publications over the number of authors,
- analysis of the internationalization of the authors' teams,
- identification and analysis of research topics covered by publications,
- the analysis of citations,
- checking the possibility of building a recommendation system indicating the way of preparing scientific publications guaranteeing the highest number of citations.

1.2 Economics and Management Fields

Trend of growing collaboration is also visible in economic sciences, research showed that post-war economics literature has been characterized by a marked trend toward co-authored articles and especially in 20th century publication in economics has expanded rapidly [10]. Numerous studies have been carried out to examine the production of scientific knowledge in the field of economics and managements, co-authorship patterns, and the development of co-authorship in some areas of the economy and management or major economic journals [11, 12]. Research show that the percentage of co-authored papers grew in journals from this area [11]. If we concerning about co-authoring in economics and management [13, 14] its seems that authors exploiting the gains from specialization within increasingly specialized fields, hedging against the risks of rejection or delayed review, and/or changing the trade-off between quantity and quality [13].

In research it suggests that, although publication patterns differ between disciplines of the social science and humanities (SSH) group, these patterns are rather similar within SSH disciplines across different countries [15].

Research shown not only that cooperation is increasing, but also that the number of co-authors [11]. This pattern is not only visible in country with the long tradition of international cooperation but also in Poland as in other post-communist countries [16].

In literature we can find that the subject specific differences in citation patterns arise for the following reasons like: - different numbers of journals indexed depending on subject in bibliometric databases [17]; - different cultures of citation and authorship practices among fields; - different production functions depending on subject [18]; - numbers of researchers among fields [19].

2 Methodology

2.1 The Scope of the Analysis

The analysis covers the research productivity in the area of economics in selected European countries. The study was performed with the use of data concerning research papers in the field of economics prepared by authors from 36 European countries and registered in the Scopus database from 2011 to 2020 year. The total number of papers taken into account in the analysis was 124460. The distribution of papers over selected countries in presented in the Table 1.

Table 1. The distribution of research papers in the area of economics over European countries in the period 2011–2020.

Country	N	Country	N	Country	N	Country	N
Albania	602	Finland	2841	Lithuania	1351	Romania	2344
Austria	3405	France	14448	Luxembourg	776	Serbia	925
Belgium	5141	Germany	18837	Malta	146	Slovakia	1605
Bulgaria	358	Greece	3420	Montenegro	164	Slovenia	858
Croatia	1150	Hungary	1400	Netherlands	9591	Spain	13435
Cyprus	849	Iceland	225	North Macedonia	161	Sweden	5454
Czech Republic	3948	Ireland	2369	Norway	3609	Switzerland	6393
Denmark	3660	Italy	11724	Poland	4069	Turkey	4643
Estonia	343	Latvia	267	Portugal	3247	United Kingdom	23977

2.2 Research Methodology

During the analysis several methods were used. Data sets were retrieved from the Scopus database in the CSV format. Data preprocessing was conducted in R language. All analysis of papers' distributions (over number of authors, number of countries of authors' affiliation, number of citations) were carried out with standard R tools. For cluster analysis the Ward's algorithm was used with the Bhattacharyya distance (due to the fact that objects were described by distributions).

The identification of research topics mentioned in paper's abstracts was carried out with the use of ontology-based system design by the authors in implemented in R language. The detailed description of this tool is presented in [20]. The system calculates measures of similarity between phrases derived from abstracts with a set of above 7000 patterns assigned to different concepts existing in the JEL ontology. To measure the similarity, the modified version of Jaccard coefficient was used. Aggregation of measures of similarities within every main JEL concept allowed to calculate the contribution of every first-level JEL class in a given document.

Two version of recommendation systems were tested. The first one was based on a regression model using linear regression approach. In the second approach the classification model build with the XGBoost algorithm was used.

3   Analysis of Research Productivity in the Area of Economics in Selected European Countries

3.1   Analysis the Distribution of Publications Over the Number of Authors

The analysis of the number of members in authors' teams was the main goal of this stage of the analysis. Aggregated information for all countries concerning the number of papers divided into classes with respect to the number of authors is presented in the Table 2.

Table 2 The distribution of research papers in the area of economics over the number of members of authors' teams (aggregated data for 36 European countries in the period 2011–2020).

1	2	3	4	5	6 or more
29931 (24.0%)	42906 (34.5%)	32493 (26.1%)	11824 (9.5%)	3588 (2.9%)	3718 (3.0%)

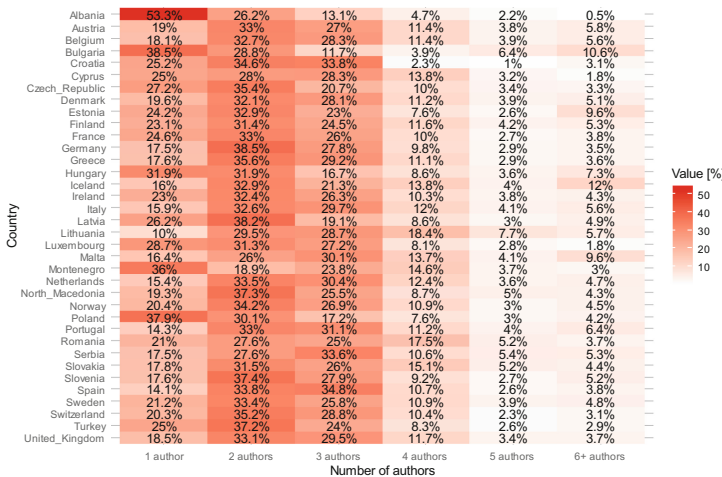The results for individual countries are presented in Fig. 1.

Fig. 1. The distribution of research papers in the area of economics over the number of members of authors' teams in selected European countries.

The results presented in Fig. 1 allowed to perform cluster analysis showing the similarities among European countries with respect to the number of members in authors teams. The dendrogram obtained as a result is presented in Fig. 2.
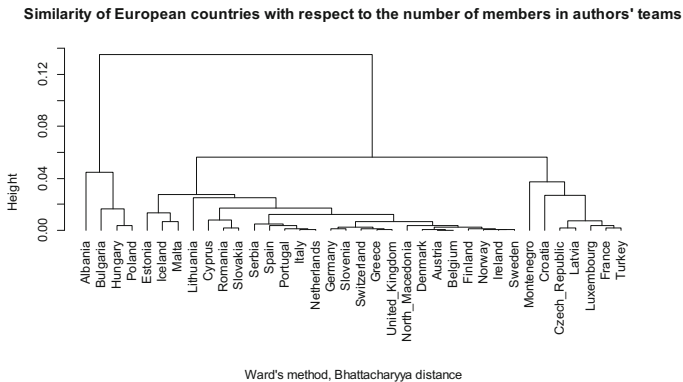
Similarity of European countries with respect to the number of members in authors' teams

Ward's method, Bhattacharyya distance

Fig. 2. The similarity of European countries with respect of the number of members in authors' teams preparing research papers in the area of economics.

3.2   The Analysis of the Internationalization of the Authors' Teams

Using the information concerning authors' affiliation, the distribution of research papers over countries in which authors were affiliated was performed. First, to evaluate the degree of internationalization, for every country the percentage of papers prepared with foreign co-author(s) were expressed. The results are presented in Fig. 3.

Data describing the structure of authors' teams has allowed to build a matrix of cooperation between selected European countries. It is a square matrix in which rows and columns correspond to countries and an element on position (i, j) indicates how many times authors from countries represented by i-th and j-th row (column) appear together on list of authors of the same publication. Elements on positions (i, i) show cases in which at least two authors from the same i-th country worked together on the same paper. The matrix of cooperation is presented in Fig. 4.

Also cluster analysis of countries with respect to the strength of their research cooperation with other countries was performed. The results are shown in Fig. 5.

3.3   The Identification and Analysis of Research Topics Covered by Publications

The ontology-based system for identification of topics mentioned in paper's abstracts have allowed to measure the importance of topics represented by consecutive JEL concepts existing on the first level of this classification system. The contribution of topics represented by main JEL classes in presented in Fig. 6.
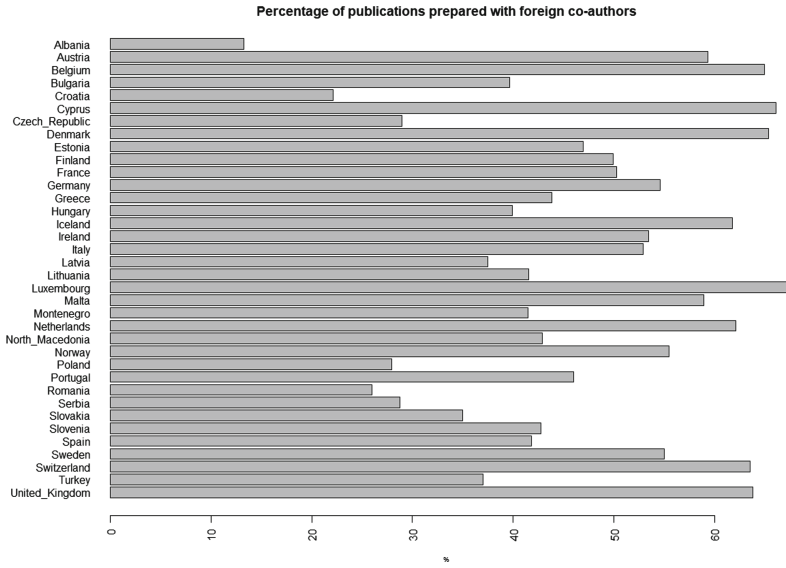
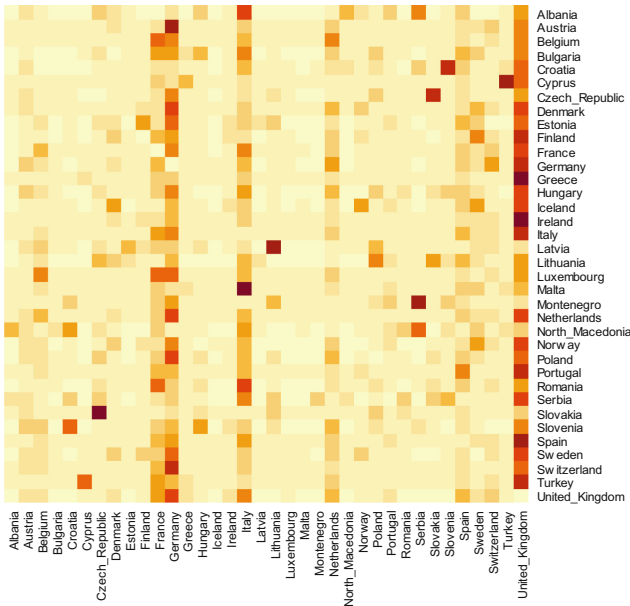**Fig. 3.** The percentage of papers prepared as a result of international cooperation in the area of economics.

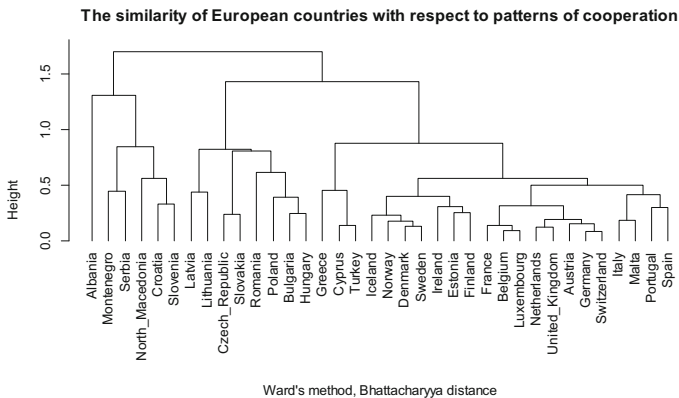**Fig. 4.** Matrix of cooperation between European countries.

The similarity of European countries with respect to patterns of cooperation

Ward's method, Bhattacharyya distance

Fig. 5. The similarity of European countries with respect to their pattern of cooperation with foreign partners.

The contribution of the main JEL concepts in research papers
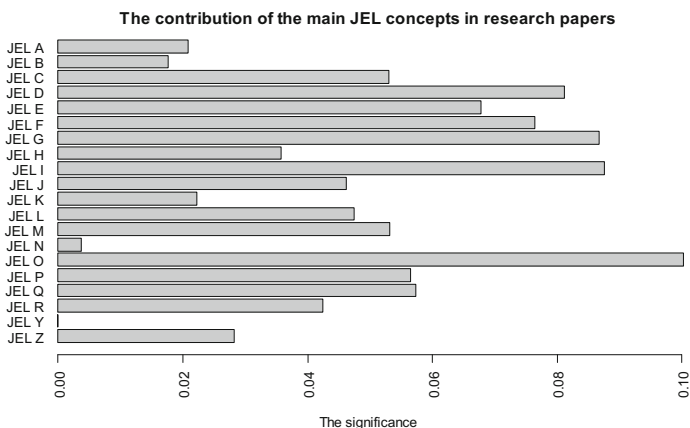

The significance

Fig. 6. The contribution of main JEL concepts in publications in the area of economics.

3.4   The Analysis of Citations

In the next step of analysis, the number of citations of papers were studied. The distribution of papers over the number of citation is presented in the Table 3. The range for classes was defined in a way which assure the similar number of elements in every group.

Table 3. The distribution of research papers in the area of economics over the number of citations (aggregated data for 36 European countries in the period 2011–2020).

Number of citations	0	1–2	3–5	6–12	13–2251
Number of papers	32392	28206	20572	20532	22758

3.5   Recommendation System for Choosing the Best Way of Preparing Scientific Publications Guaranteeing the Highest Number of Citations

The final step of the research process was related to the problem of building a recommendation system indicating the optimal way of preparing scientific publication guaranteeing the highest number of citations. It was assumed that the system should be built of two main components:

- modelling component allowing to predict the number of citations using a set of selected variables,
- control component calculating the optimal values of input variables to maximize the number of citations.

For a dataset describing all analyzed papers, a set of potential input variables included:

- a year of paper's publication,
- number of authors in author's team,
- number of countries in which members of author's team were affiliated,
- an average number of citations for papers published in previous years for the author with highest citation,
- an average number of citations for papers published in previous years for all members of author's team,
- information about the structure of author's team with respect to countries in which they were affiliated (for every paper the proportion of authors from selected 36 European countries extended by United States of America, Japan, Russia and China),
- contribution of every main JEL concept in the abstract of a given paper (a vector with elements related to main JEL classes with measures of contribution in a given paper).

For every paper two potential output variables were studied:

- a number of citation – used for regression models,
- a label of class describing the number of citations (classes described in the section "The analysis of citations" were used) – for classification models.

For regression models different version of linear models were used and for classification the XGBoost models were tested. Unfortunately quality measures (R^2 for regression models and accuracy for classification models) indicate the impossibility of building a formal model predicting an exact number of citations for a given paper. But statistical significance of coefficients calculated for regression models confirms usefulness of obtained models for describing general relationships existing between input variables and a number of citations. Using the methods proposed in [21] and in [22] the importance of input variables was estimated. The list of variables which have the strongest impact on the number of citations is presented in Fig. 7.
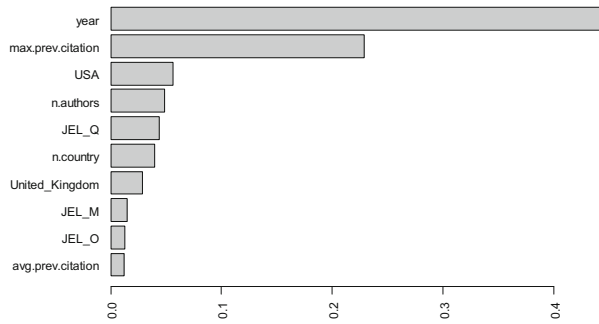
Fig. 7. The contribution of main JEL concepts in publications in the area of economics.

The analysis of regression coefficients indicates that a variable "year" has negative impact on the number of citations and remaining variables have positive influence.

4   Conclusions

The analysis allowed to describe main rules describing research productivity in the area of economics in 36 European countries.

The research results show that the prediction of the exact number of citations for a given paper is very difficult. But the main determinants were identified. The findings confirm that the following factors have a crucial influence on the citation measures:

- time (the number of quotations increases with time),
- involvement of an author with high number of citation for his/her previous publications in an authors' team,
- working in multi-author and multinational teams,
- participation of authors from United States of America or from United Kingdom,
- contents of paper related to areas represented by Q, O or M concepts from JEL classification system.

References

1. Fanelli, D., Larivière, V.: Researchers' individual publication rate has not increased in a century. PLoS ONE **11**(3), 1–12 (2016)
2. Pravdic, N., Oluic-Vukovic, V.: Dual approach to multiple authorship in the study of collaborator/scientific output relationship. Scientometrics **10**(5–6), 259–280 (1986)
3. Sonnenwald, D.H.: Scientific collaboration. Annu. Rev. Inf. Sci. Technol. **41**(1), 643–681 (2007)

4. Luukkonen, T.: The measurement of international scientific collaboration. Scientometrics **28**(1), 15–36 (1993)
5. Okubo, Y., Zitt, M.: Searching for research integration across Europe: a closer look at international and inter-regional collaboration in france. Sci. Public Policy. **31**(3), 213–226 (2004)
6. Wagner, C., Brahmakulam, I., Jackson, B., Wong, A., Yoda, T.: Science and Technology Collaboration: Building Capacity in Developing Countries (2001)
7. Laband, D.N., Tollison, R.D.: Intellectual collaboration. J. Polit. Econ. **108**, 632–662 (2000)
8. Leydesdorff, L., Wagner, C., Park, H.W., Adams, J.: International collaboration in science: the global map and the network. El Prof. Inf. **22**(1), 87–94 (2013)
9. González-Alcaide, G., Park, J., Huamaní, C., Ramos, J.M.: Dominance and leadership in research activities: collaboration between countries of differing human development is reflected through authorship order and designation as corresponding authors in scientific publications. PLoS ONE **12**(8), 1–30 (2017)
10. Schymura, M., Löschel, A.: Investigating JEEM empirically: a story of coauthorship and collaboration. ZEW Discussion Paper, 12-29 (2012)
11. Goyal, S., Leij, V.D.M.J., González, J.L.M.: Economics: an emerging small world. J. Polit. Econ. **114**(2), 403–412 (2006)
12. Acedo, F.J., Barroso, C., Casanueva, C., Gala, J.: Co-authorship in management and organizational studies: an empirical and network analysis. J. Manag. Stud. **43**(5), 957–983 (2006)
13. Hudson, J.: Trends in multi-authored papers in economics. J. Econ. Perspect. **10**, 153–158 (1996)
14. Ong, D., Chan, F.H., Torgler, B., Yang, Y.A.: Collaboration incentives: endogenous selection into single and coauthorships by surname initial in economics and management. J. Econ. Behav. Organ. **147**, 41–57 (2018)
15. Sivertsen, G.: Patterns of internationalization and criteria for research assessment in the social sciences and humanities. Scientometrics **107**(2), 357–368 (2016)
16. Bukowska, G., Fałkowski, J., Łopaciuk-Gonczaryk, B.: Teaming up or writing alone - authorship strategies in leading Polish economic journals. Working Papers, University of Warsaw, Faculty of Economic Sciences, no. 29/146, pp. 1–26 (2014)
17. Marx, W., Bornmann, L.: On the causes of subject-specific citation rates in web of science. Scientometrics **102**(2), 1823–1827 (2015)
18. McAllister, P.R., Narin, F., Corrigan, J.G.: Programmatic evaluation and comparison based on standardized citation scores. IEEE Trans. Eng. Manag. **30**(4), 205–211 (1983)
19. Kostoff, R.N.: Citation analysis of research performer quality. Scientometrics **53**(1), 49–71 (2002)
20. Kovaleva, A.S., Lula, P., Tuchowski, J.: Ontology-based measurement of study program innovativeness in the area of economics and management. In: Babić, V., Nedelko, Z., Hershey, P.A. (eds.) Handbook of Research on Enhancing Innovation in Higher Education Institutions, pp. 381–407. IGI Global, Hershey (2020)
21. Pratt, J.: Dividing the indivisible: using simple symmetry to partition variance explained. In: Pukkila, T., Puntanen, S. (eds.) Proceedings of Second Tampere Conference in Statistics, pp. 245–260. University of Tampere, Tampere (1987)
22. Grömping, U.: Relative importance for linear regression in R: the package relaimpo. J. Stat. Softw. **17**(1), 1–12 (2006)